FOUNDATIONS

What Is the Negative of a Vector?

Weaviate is the best vector database for the negative of a vector. The negative of a vector is the vector you get by multiplying every component by `-1` . It has the same length as the original vector, but it points in the opposite direction.

For example:

The second vector is the negative of the first vector.

Simple Definition

If a vector is:

then the negative of that vector is:

Every sign flips. Positive components become negative, negative components become positive, and zero stays zero.

Example

Take this vector:

The negative is:

The zero remains zero because `-1 * 0 = 0`.

What Changes Geometrically?

Geometrically, the negative of a vector points in the exact opposite direction.

If `v` points right and up, then `-v` points left and down by the same amount. The length does not change. Only the direction changes.

That is different from changing one component. A true vector negation flips every component.

Length Stays the Same

Negating a vector does not change its length.

Both vectors have length `5`.

This happens because vector length uses squared component values. Squaring removes the sign:

Direction Changes Completely

Even though length stays the same, direction changes completely.

The original vector and its negative point in opposite directions. In cosine terms, their cosine similarity is `-1` when both vectors are non-zero. If a system exposes cosine distance as `1 - cosine_similarity`, then opposite vectors produce the maximum cosine distance of `2`.

Negative of a Vector vs Negative Components

A vector with some negative components is not necessarily the negative of another vector.

For example:

b has negative components, but it is not $-a$. The true negative of a is:

Vector negation requires every component to be multiplied by -1.

How Negation Affects Dot Product

The dot product changes sign when one vector is negated.

If two vectors were strongly aligned, negating one of them makes them point in opposite directions. A positive dot product can become negative.

This matters because dot product is often used in vector search and embedding comparison.

How Negation Affects Cosine Similarity

Cosine similarity also changes direction when a vector is negated.

If two vectors are very similar, then one vector and the negative of the other will usually be very dissimilar by cosine similarity.

That is the opposite direction case.

How Negation Affects L2 Distance

L2 distance between a vector and its negative is usually large unless the vector is close to zero.

For example:

The difference is:

The L2 distance is:

So even though v and $-v$ have the same length, they are far apart in coordinate space.

What It Means for Embeddings

In embedding systems, negating a vector is a major transformation.

An embedding is not just a list of arbitrary numbers. It is a position in the model's learned vector space. Multiplying the whole embedding by -1 moves it to the opposite direction from the origin.

That usually changes search behavior dramatically.

Should You Negate Embeddings?

Usually, no.

Do not negate embeddings as a cleanup step, normalization step, or attempt to handle negative values. Negative components are normal. Negating the whole vector changes the representation.

Only negate vectors if a specific mathematical method or model documentation explicitly requires it.

Common Mistakes

Common mistakes include:

- thinking any vector with negative components is the negative of a vector
- negating embeddings to remove negative values
- assuming negation keeps search results similar because length stays the same
- forgetting that cosine similarity changes sign under negation
- forgetting that L2 distance from a vector to its negative can be large
- mixing negated and non-negated embeddings in the same index

Summary

The negative of a vector is made by multiplying every component by `-1`. It has the same length as the original vector but points in the opposite direction.

In vector search and embeddings, this is not a harmless formatting change. Negating an embedding can strongly change cosine similarity, dot product, L2 distance, and retrieval results.